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SPECIFICATION FOR BACK-SILVERED MIRRORS USED IN INSTRUMENT INDUSTRY

UDC 535.87 : 681.2

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MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110001

November 1973

AMENDMENT NO. 1 NOVEMBER 1980

TO

IS:7011-1973 SPECIFICATION FOR BACK-SILVERED MIRRORS USED IN INSTRUMENT INDUSTRY

Alteration

(*Page 4, clause 3.1.1*) - Substitute the following for the existing clause:

'3.1.1 A suitable treatment may be given to improve adhesion of the silver layer. One of the recommended compositions of the solution for the treatment of mirror blanks for this purpose is given below:

Stannous chloride	10 g
Hydrochloric acid	40 ml
Water	1 l

NOTE - This solution sensitizes the glass surface to receive a mirror type film. It is equally important to carefully wash off all traces of the solution before metal surface is precipitated.'

(EDC 36)

Reprography Unit, ISI, New Delhi

AMENDMENT NO. 1 NOVEMBER 1980

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NOTE - This solution sensitizes the glass surface to receive a mirror type film. It is equally important to carefully wash off all traces of the solution before metal surface is precipitated.'

(EDC 36)

AMENDMENT NO. 2 APRIL 1987

TO

IS:7011-1973 SPECIFICATION FOR BLACK-SILVERED MIRRORS USED IN INSTRUMENT INDUSTRY

[*Page* 4, *clause* 3.1.1 (*also see Amendment No.* 1)] - Add the following Note 2 after the existing Note:

'NOTE 2 - Before use, manufacturer shall ensure the quality of the stannous chloride.'

(EDC 36)

Reprography Unit, ISI, New Delhi, India

Indian Standard

SPECIFICATION FOR BACK-SILVERED MIRRORS USED IN INSTRUMENT INDUSTRY

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(*Continued on page* 2)

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Indian Standard

SPECIFICATION FOR BACK-SILVERED MIRRORS USED IN INSTRUMENT INDUSTRY

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 16 August 1973, after the draft finalized by the Optical and Mathematical Instruments Sectional Committee had been approved by the Mechanical Engineering Division Council.

0.2 Back-silvered mirrors may be used in situations where the reflection from front surface is not likely to have an adverse effect on the quality of image. Resistance of such mirrors to the normal atmospheric conditions is good. The deposited metal withstands sudden variations of temperature without loosening up under the contraction resulting from age-drying.

0.3 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test, shall be rounded off in accordance with IS : 2-1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

1. SCOPE

1.1 This standard specifies the requirements of back-silvered mirrors intended:

a) for use in air-tight instruments, and

b) for general use where the mirror is exposed to the atmosphere.

2. MATERIAL

2.1 Only transparent blanks shall be used for production of back-silvered mirrors and these blanks have to be reasonably free from seeds, striae, strains or surface-defects likely to be detrimental to the performance of the mirror or to be a cause of spoiling its appearance unduly. Glasses

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*Rules for rounding off numerical values (*revised*).

which have a high soda-content should not be used as they cause silvering to grow yellow with age. Where the quality of image is important, as in the optical instruments, only glass of optical quality (as specified in **2.2**) having the permissible transmission/refraction characteristics commensurate with the design requirements should be used.

2.2 Quality of Blanks — While selecting blank for production of these mirrors, the following points should be kept in view:

a) Both surfaces of the blank should be polished to a high degree of finish in accordance with the design requirements, and

b) The surface to be silvered should be free from defects like scratches, sleeks or pits which are likely to manifest themselves appreciably after silvering (*see also* Appendix A).

2.3 Chemicals — All the chemicals to be used in the process of silvering should be of analytical or guaranteed reagent grade. They should be stored in such a way that there is little deterioration during their shelf-life. The silver salts have to be stored in dark bottles away from too much light.

3. GENERAL REQUIREMENTS

3.1 Silvering — The silver may be deposited by a chemical process or by using the technique of vacuum-deposition whichever is found to be more convenient and economical in a particular situation.

3.1.1 A substratum of some suitable material may preferably be given to improve adhesion of the silver layer, provided the reflection loss is not too much and the intensity of reflected light is commensurate with the design requirements.

3.2 Backing — Suitable protective backing should invariably be applied to the silvered surface of back-silvered mirrors. The first layer may be of copper applied by electro-deposition, reduction-deposition or vacuum-evaporation. It should, however, be free from pores so that adequate protection is available from atmospheric chemical reaction. In the case of mirrors which are intended to be used in non-airtight optical instruments which remain exposed to the atmosphere or which are meant for general use, a second layer may be applied which should be of lead having a minimum thickness of 0·025 mm. All the mirrors should, however, have a final layer of a suitable non-porous paint or varnish. The paint or varnish used for this purpose should be such that it does not harm the deposited metal when subjected to sudden temperature changes or when age-dried by hardening over the years. Normally the backing should be capable of maintaining its non-porous and protective characteristics at a maximum temperature of 100°C for about 5 000 hours.

4. FUNCTIONAL REQUIREMENTS

4.1 Reflection Factor — In the visible spectral region, the reflection percentage, expressed as a luminance ratio for an incidence angle of 45° should be at least 80 though figures as high as 94 may be achieved, if adequate care is taken and the chemicals used are of the highest purity. The process adopted should be such as to give a value commensurate with the design requirements without involving unnecessary cost due to over-grading.

5. GRADING

5.1 The purchaser or designer shall indicate the grading of the mirror keeping in view the manner and the conditions in which it is to be used. The grading of the mirror is a combination of different classes of freedom from surface defects, resistance to atmospheric attack and reflection factors as given in Appendices A, B and C respectively.

6. TESTS

6.1 General — While testing the mirror for the values for different classes specified in Appendices A, B and C, it shall be ensured:

a) that the tests are adequate to meet the purchaser's requirements,

b) that none of the tests is stringent beyond requirements expected from such mirrors,

c) that reliability of the tests employed is not overlooked, and

d) that practical point of view is not ignored.

6.2 Visual Tests

6.2.1 The mirror shall be free from blisters and greasiness. While looking at the mirror against light incident at a steep angle no film shall be observed and there shall not be any change in colour while the angle of incidence is altered.

6.2.2 Pin holes shall be checked by looking at the mirror held against a filament of 250 W incandescent lamp.

6.2.3 The mirror shall be reasonably free from pits, pin holes, scratches and sleeks according to the specified classes.

6.3 Functional Tests

6.3.1 The definition and parallelism of a plane mirror shall be tested with a suitable auto-collimator. The reflected image shall be clear and reasonably free from aberrations or duplication.

6.3.2 The definition of a concave or convex mirror may be checked by the heliographic method of mirror testing as follows:

a) A suitable test chart set up at a convenient distance is viewed through a telescope,

b) Reflected image of this test chart from the mirror under test is then seen through the same telescope,

c) Quality of the images in the two cases is compared to get an idea of the definition of the mirror. A resolution chart may be used if necessary, and

d) The entire surface of the mirror under test should be used in the process of image formation.

6.3.2.1 The reflected image of the chart as seen through the telescope shall be clear and reasonably free from aberrations.

6.3.3 The method of measuring reflection factor by determining the luminance ratio may be applied to plane or curved surfaces keeping the following points in view:

a) The area under examination should be completely covered with the light from the incident beam,

b) Luminance of the light source which may be part of a uniformly diffusing surface should be measured using a fairly stabilized photometer,

c) The mirror under measurement should then be so mounted that light from the same part of the source completely covers the area under test at an angle of incidence equal to 45°,

d) The luminance of the reflected beam should be measured using the same photometer under the same setting and under the same degree of stabilization,

e) The first value of reflection factor may then be taken as the ratio of the second reading to the first,

f) A third reading should be taken after removing the mirror under measurement and bringing back the source to its former position so that luminance of the source is once again measured,

g) Second value of the reflection factor may then be taken as the ratio of the second reading to the third,

h) Mean of the two values may be regarded as the reflection factor of the mirror, and

j) Care should be taken that no light is reflected back by the mirror on to the light source as this may increase the reading giving a false notion of a higher reflection factor.

6.3.3.1 Usual precautions that are necessary while taking photometric readings should be observed and the limitations of a photo-cell/photo-multiplier should be kept in view while forming an opinion.

6.4 Climatic and Durability Test

6.4.1 Humidity, heat, cold and corrosion tests shall be carried out on a small percentage of mirrors selected at random.

6.4.2 There shall not be any deterioration in the silvered film and its protective coating after the completion of tests laid down in Appendix B.

7. MARKING

7.1 The back-silvered mirrors shall be marked at a suitable place with the manufacturer's name or trade-mark.

7.1.1 The back-silvered mirrors may also be marked with the ISI Certification Mark.

NOTE — The use of the ISI Certification Mark is governed by the provisions of the Indian Standards Institution (Certification Marks) Act and the Rules and Regulations made thereunder. The ISI Mark on products covered by an Indian Standard conveys the assurance that they have been produced to comply with the requirements of that standard under a well-defined system of inspection, testing and quality control which is devised and supervised by ISI and operated by the producer. ISI marked products are also continuously checked by ISI for conformity to that standard as a further safeguard. Details of conditions under which a licence for the use of the ISI Certification Mark may be granted to manufacturers or processors, may be obtained from the Indian Standards Institution

8. PACKING

8.1 The mirrors shall be suitably packed in tissue paper and cotton free from acid or grease.

APPENDIX A

[*Clauses* 2.2(b), 5.1 *and* 6.1]

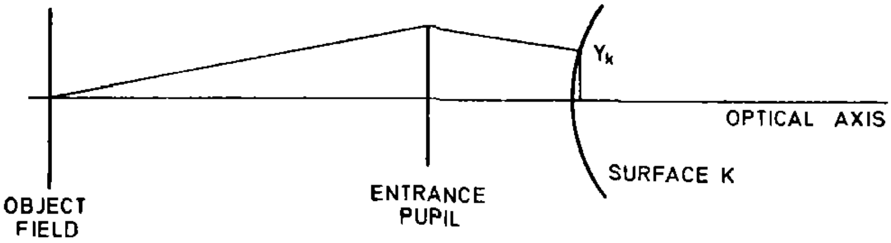
CLASSES FOR INDICATING FREEDOM FROM SURFACE DEFECTS

A-1. NOTATION

A-1.1 In the case of reflecting surfaces used in the optical systems of instruments, two parameters Y and D are used for this purpose which may be expressed as below:

Y = height (in mm) of the 'marginal ray', that is, a ray from the centre of the object field to edge of the entrance pupil at the surface under consideration.

D = sum of all the sides of the mirror divided by π.



A-2. CLASSES

A-2.1 The different classes for indicating freedom from surface defects are given below:

Class	Υ	*Maximum Cummulative Length of Scratches Allowed*	*Maximum Width of Scratches Allowed* mm	*Maximum No. of Pits/Pin Holes Allowed*	*Maximum Diameter of Pits/Pin Holes Allowed* mm
A : 1	< 0·5	Less than *D*	0·001	Less than 0·25 *D*	0 002
A : 2	< 5	Less than *D*	0.002	Less than 0·25 *D*	0·004
A : 3	< 10	Up to *D*	0·005	Up to 0·35 *D*	0·05
A : 4	< 50	Up to 1·5 *D*	0·01	Up to 0·45 *D*	0·10
A : 5	< 100	Up to 2 *D*	0·02	Up to 0·5 *D*	0·15
A : 6	> 100	Up to 2 *D*	0·04	Up to 0·5 *D*	0·20

NOTE — In the case of mirrors used alone, *D* may be used in place of Υ for determining the class.

APPENDIX B

(*Clauses* 5.1, 6.1 *and* 6.4.2)

CLASSES FOR INDICATING RESISTANCE TO ATMOSPHERIC ATTACK

Test	*Class B* : 1	*Class B* : 2
Humidity (for 24 hours)	95 percent at 55°C	95 percent at 40°C
Heat (for 16 hours)	At 70°C	At 55°C

Test	*Class B* : 1	*Class B* : 2
Cold (for 4 hours)	At −30°C	At 0°C
Anticorrosion (in suitable saline water)	For four hours	For two hours

Note 1 — The details specified above give an indication of the values on the basis of which a particular class should be specified by the designer from amongst the two categories *B* : 1 and *B* : 2 which apply to the reflecting surfaces used in instruments and for general use respectively.

Note 2 — The tests given are recommended only for the purpose of type approval tests.

APPENDIX C

(*Clauses* 5.1 *and* 6.1)

CLASSES FOR INDICATING REFLECTION FACTOR

Class	*Value of the Reflection Factor in the Visible Spectrum Region*
C : 1	Not less than 90
C : 2	Not less than 85
C : 3	Not less than 80

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